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APPENDIX C

BONNEVILLE POWER ADMINISTRATION'S
SYSTEM LOAD SHAPING GUILDELINES
REGARDING TURBINE OPERATION
AND BEST EFFICIENCY

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Bonneville Power Administration's System Load Shaping Guidelines Regarding Turbine Operation and Best Efficiency

1. Background: Outmigrating juvenile salmonids have several potential routes of passage past hydroelectric dams on the mainstem Columbia and Snake Rivers, including turbines, mechanical bypass, sluiceways, and spillways. Fish passage survival varies depending on the route of passage. As a result of reported higher mortality rates for fish passage through turbines (Iwamoto and Williams 1993), regional efforts have been focused on providing non-turbine passage routes for juvenile fish as a means to improve fish survival through the FCRPS. Nevertheless, substantial numbers of juvenile fish will continue to pass through turbines; therefore, effort to minimize turbine-related mortality is a priority of the fishery agencies and Indian Tribes, National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries, formerly National Marine Fisheries Service [NMFS]), U.S. Army Corps of Engineers (Corps), and Bonneville Power Administration (BPA).

Kaplan turbine operating efficiency has a relatively direct effect on fish passage survival. The relationship between survival of juvenile fish passing through Kaplan turbines is positively correlated and roughly linear to the efficiency at which the turbines are operated. Bell (1981) recommended making every effort to operate turbines at best efficiency at a given head during periods of peak fish passage to minimize fish mortality.

2. Turbine Efficiency: For the purposes of this document, best turbine efficiency operation shall be based on efficiency tables provided by the Corps for each project in the Fish Passage Plan (FPP). The Corps shall ensure that these efficiency ranges are based on the best available information, and that updates are coordinated with BPA, the Fish Passage Operation and Maintenance Coordination Team (FPOM), and operating agencies. The tables will be distributed to all operating agencies prior to implementation, allowing up to two weeks after receipt of the tables for implementation.

Operating efficiency of turbines is a result of wicket gate opening and blade angle for a given head (Bell 1981). As a result, there is a family of turbine efficiency curves for each project (or turbine design) for various head differentials. Operational decisions affecting turbine operations are based on

efficiency curves for incremental changes in head, as provided by turbine manufacturers or empirical testing.

3. Guidelines:

a. Objective: To reduce the mortality of out migrating juvenile salmonids, BPA will provide the Corps' hydro system projects with generation requests that allow turbines at the Lower Snake (LSN) and Lower Columbia (LCOL) projects to operate within 1% of best efficiency, or as otherwise specified, during the Best Efficiency Operating Period, within the guidelines outlined below.

b. In season Best Efficiency Operating Period: This period is defined as 24 hours per day from April 1 through October 31 for all LCOL river and LSN river projects. BPA will maintain generation requests that allow turbines to operate within 1 percent of best efficiency in accordance with these guidelines. When units operate outside 1% of best efficiency during this period the excursions will be tracked using the codes in Table 1.

c. Off season operations: While not required to do so, during the period of November 1 through March 31 turbines will normally run within the 1% range since it is the optimum point for maximizing the energy output of a given unit of water over time. As units are added, they will be operated within the 1% range until maximum generation limit of the 1% range for the project is reached. Then operation outside 1% is allowed if needed for power generation or other needs. Additional details of the 1% operation may also be found in each project’s section of the Fish passage Plan labeled “turbine unit operation and maintenance”. There are no reporting requirements for this period.

d. Unit priorities: The Corps should make every effort to adhere to the unit operating priorities specified in the FPP (the order in which turbines are put on or taken of line). The Corps shall follow a unit priority list that specifies which units at each LSN and LCOL project should be operated within the range of best efficiency to minimize impact to salmon stocks. The Corps through the FPOM process will develop a sequence for operating units outside of the 1% of best efficiency range, if it is necessary to operate units in this manner during the fish migration season. Both unit priority sequences will be based on the best available fish passage and turbine efficiency information in the FPP.

e. Project Priorities: If units must be operated out of the 1% of best efficiency range, BPA will make every effort to assure that generation requests to the Corps projects adhere to project priorities (emergencies, spill management, research, etc). These priorities may be developed weekly, based on in-season fish passage information, by the Action Agencies through the Technical Management Team (TMT).

f. Coordination: Coordination will occur through existing interagency coordinating mechanisms, such as the in-season management process described in the 2004 Updated Proposed Action prepared by the Corps, U.S. Bureau of Reclamation, and BPA (Action Agencies).

Coordination is also intended to allow the action agencies sufficient lead time to include system operational changes in their planning activities. Sufficient time is defined as the time needed to enter the information into the GDACs system (COE) and the Columbia Vista model (BPA). This can take up to two weeks to accomplish. If an emergency situation exists, implementation will begin as soon as practical given concurrent operations, hydraulic situations and loads.

Reasonable and prudent operations outside of best efficiency for limitations listed in paragraphs 4.a (system reliability) and 4.b (routine starting) are at the discretion of the BPA and Corps. BPA and the Corps will coordinate with NOAA Fisheries when operation of turbines outside of the best efficiency range may be appropriate under provisions in paragraphs 4.c (total dissolved gas) through 4.h (flood control). Additional coordination may also occur during the next scheduled TMT meeting.

Emergency situations, described in paragraph 4.a (system reliability), that require an immediate change in FCRPS operation will be coordinated directly by the action agencies with NOAA Fisheries when time allows. If coordination of an emergency change in FCRPS operation cannot be completed immediately, information will be supplied to the TMT as soon as practical. The action agencies shall establish points of contact with the appropriate agencies to allow such emergency coordination to occur.

g. Grand Coulee (GCL) and Chief Joseph (CHJ) Flexibility: Within system reliability and firm load limitations, flexibility at GCL and CHJ will be fully used, whenever possible, before generation requests to LCOL and LSN projects are outside the best efficiency range.

4. Limitations for the period April 1 through October 31: There are a number of conditions that occur in the system that will limit the Corps and BPA ability to operate the turbines continuously within the 1% best efficiency range. These include the following:

a. System Reliability: BPA's ability to operate the power system in a manner that enables the Corps to maximize operation of turbines within best range will be constrained by requirements to maintain system reliability (including requirements necessary for transient and voltage stability of the transmission system), and the ability to meet system response criteria. Additionally, it is necessary to maintain a margin of resource generation on line to fulfill Northwest Power Pool (NWPP), Western Electricity Coordinating Council (WECC), and the North American Electric Reliability Council (NERC) reliability requirements. If BPA overrides the BIOP operations for system reliability, BPA will provide an automated e-mail to the Corps. For longer term emergencies, see Water Management Plan Appendix 1. Emergency Protocols.

BPA's Reliability Criteria for Operations, the Northwest Power Pool Operating Manual, the Western Systems Coordinating Council Operations Committee Handbook, and the North American Electric Reliability Council Operating Manual define system response criteria and margin of resource generation. According to the Regional Act, the Power Sales Contract with the DSIs and House Report 96-976, dated September 16, 1980," the total DSI load will be considered firm for purposes of resource operation."

Predictable instances of deviation from within the best range as a consequence of prudent utility operation for control of short-term system dynamics include:

1) Routine responses to loss of generation, load or transmission within the interconnection including delivery of Operating Reserve Obligation to NWPP members upon request. The duration of these deviations is minimal, but dependent upon recovery by the interconnection member with the problem.

2) Deliberate dropping of generation, i.e., instantaneous interruption of output, to preserve system integrity. This dropping could cause a brief excursion.

b. Routine start up and stop: Routine starting and stopping of generation units are unavoidable deviations, usually short in duration but on occasion can extend beyond the 5 minute reporting window. (see section 5 for reporting criteria)

Implementation of operations 4c through 4h will include a lead time of at least two working days for NOAA Fisheries to evaluate the effects of the proposed actions (non-emergency situations).

c. Total Dissolved Gas Supersaturation (TDG): The TDG levels will be monitored at each project during the fish passage season. Signs of gas bubble disease will be monitored at all Smolt Monitoring Program sampling sites and selected in-river sites. Best turbine efficiency operation may be modified if representative monitoring data indicate that TDG is affecting fish survival. Necessary operational modifications will be coordinated through the process outlined in paragraph 3.f (coordination).

d. Coordinated Fishery Operations: In the event that coordinated fishery operations and approved fishery research are not in accord with operating turbines at best efficiency, operational modifications will be coordinated through the process outlined in paragraph 3.f (Coordination).

e. Flow Augmentation Operations: Flow augmentation requests for LCOL flows at McNary (MCN) are primarily met by water releases from GCL. The decision on whether to use GCL flexibility to provide inflows to MCN at the level necessary to meet the week's LCOL flow request when fish collection is maximized for transport during the flow augmentation period shall be made through the coordination process outlined in paragraph 3.f (coordination).

The TMT flow augmentation requests may exceed the 1% best efficient operation range at LCOL/LSN projects. Meeting this flow request will take precedent over best efficient operations. Coordination of the implementation of the flow requests will occur through the process outlined in paragraph 3.f (coordination).

f. Transport Projects: Resolution of the conflict between spill management and turbine operation within 1% of best efficiency at transport projects during the transport season shall be determined through the coordination process outlined in 3.f., and in accordance with fish transportation guidelines, based on in-season flow and fish passage information. Care should be taken during transition periods close to the upper flow boundary to avoid frequent switching of priorities between spill and generation.

g. Routine Maintenance and Testing: All units at all projects must undergo maintenance and associated testing. The testing necessitates deviation from the 1% best efficiency band for periods of from 15 minutes to 8 hours. Scheduling of maintenance testing will be coordinated through the process outlined in 3.f., to ensure that it is conducted during times of low fish passage within a day to minimize impacts on fish.

h. Flood Control: The FCRPS provides multiple benefits to the region. Flood control is the primary function of many of the projects on the Columbia River. In the event that river flow conditions require flood control operations, operation of turbines within the 1% best efficiency range may be modified or suspended based on the Corps' direction. Allowing excursions from 1% best efficiency for flood control operations would facilitate transportation, reduce excessive dissolved gas levels, and lower the risk of gas bubble disease in fish. Coordination of flood control operations will occur as outlined in paragraph 3.f (coordination). See also paragraphs 4.c (total dissolved gas) and 3.g (Grand Coulee and Chief Joseph Flexibility).

i. Other: In the event that the excursion was not explainable or caused by human error.

5. Quality Control: Significant deviations from 1% will be recorded. Data on unit status will be compiled by BPA during the 1% operating season and provided to the COE monthly. Documentation will be kept when excursions 1) exceed 15 minutes in duration; and or (2) occur five or more times exceeding 5 minutes within a calendar day. The reason (limitation or other factor) for the excursions will be kept in project logs at each dam as well as inserted into the spreadsheet provided by BPA using the reason codes listed in Table 1 below. The COE will annually provide a report to NOAA Fisheries of reportable excursions from the 1% operating range during the 1% operating season.

Upon request of the TMT, a case-by-case brief explanation of the reason(s) for unit operation outside the 1% of best efficiency range, the date, and the length of time outside the range, will be provided by the appropriate parties.

For the report, the following numerical codes will be used to explain the excursions outside the 1% best efficiency range. The codes provide a more simplified method of tracking excursions than using the listed limitations in section 4.

Table 1: Codes for 1% reporting

Code	Reason
1	Equipment reporting errors, including lack of data (for example GDAC or AGC not operating correctly and not recording the readings, dead band and precision issues)
2	Changing spill levels in support of NMFS Biological Opinion or court order (for example, requested flow augmentation, coordinated fisheries operation)
3	O&M requirements (for example, fish screen inspection, trash racking, doble testing ,or dam safety)
4	Operational tests (for example index testing, testing new equipment , calibrating new or repaired equipment)
5	BPA requested operation (request operation via the AGC)
6	Turbine startup or stops that take longer than 5 minutes
7	Emergency conditions or system failures (these include transmission system emergencies, remedial action schemes (RAS), also see section 4.a system reliability)
8	Fish research
9	Human error
10	Unknown causes
11	Please specify new reason
12	Flood control
13	Reducing TDG levels